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MITRAILLEURS
OR
MACHINE GUNS.

CAPTAIN J. F. OWEN, R.A.

231. d.
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COMPOUND GUNS,

MANY-BARRELLED RIFLE BATTERIES,

MACHINE GUNS, OR MITRAILLEURS.

BY

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PREFACE.

Mitrailleurs or machine guns have attracted a great deal of attention of late years, and now constitute a part of the armament of most great powers. A succinct account of their gradual introduction, and description of those used by different nations will therefore, I trust, be found of some interest.

In 1869, our own Government, finding that in France and Belgium weapons of this nature were being manufactured in considerable numbers, purchased mitrailleurs, both on the Montigny and Gatling principles; and in 1870 a Special Committee was appointed to report upon them, and on mitrailleurs in general.*

To the two reports of this Committee, dated November, 1870, and November, 1871; to an interesting lecture delivered at the U.S. Institution, London, in January, 1872, by Colonel Fletcher, Scots Fusilier Guards (one of the Special Committee); and also to the report of a Swedo-Norwegian Commission of Officers,† and an article upon the same in the "Revue d'Artillerie" for February, 1874, I am indebted for most of the information given in the following pamphlet.

J. F. O.

Woolwich,
July, 1874.

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* Major Fosberry, V.C., Bengal Staff Corps, was urgent in bringing these weapons—the use of which he strongly advocated—to the notice of our Government. *Vide* "Journal, U.S.I.," No. LVI., for a paper of his upon their value.

† This report, translated by Captain King Harman, R.A., has been published with "Proceedings, R.A. Institution," Woolwich.

COMPOUND GUNS, MANY-BARRELLED RIFLE BATTERIES, MACHINE GUNS, OR MITRAILLEURS.

PART I.

"Because you have to fight with machines instead of lances, there may be a necessity for more ghastly danger, but there is none for less worthiness of character than in olden time. You may be true knights yet."—*Ruskin.*

WEAPONS called by some of the many names in my heading have so recently come into vogue for modern war that we are apt to consider them entirely an invention of our own day, and to a great extent they undoubtedly are so.

So powerful are sentiment and prejudice, that the use of these many-shooting firearms was at first looked upon as almost unsoldierlike; and hard terms—such as "horrible" and "diabolical"—were freely bestowed upon them. Such ideas, of course, disappeared when the employment of mitrailleurs ceased to be a novelty; their absurdity becomes fully evident when we observe the object of using the arms in question.

On the introduction of rifled field guns, it appeared that the rotatory motion imparted to the projectile somewhat decreased the effect of case shot; while shell fire (until fuzes are much improved) must always be more or less uncertain.

Mitrailleurs were therefore made, with a view to their affording a fire like that of case (*mitraille*), or a hail of bullets, for ranges up to 1000 or 1200 yds. This term, of French origin, has been found inconvenient to the Anglo-Saxon tongue, and consequently has not been adopted by the Americans or ourselves for the machine guns which we use. We designate them by the name of the inventor, and call them "guns."

We must not imagine that guns with many barrels were not used before the Franco-German war of 1870–1.

Fire-arms having many barrels, intended either to be fired together or in rapid succession, are by no means a modern conception; although the introduction of rifling and metallic cartridges has of course revolutionised their nature and manufacture.

In the earliest days of artillery, we find machines used under the names of ribaudequins, orgues,* orgels, organ or tube guns, &c., in which several barrels of small calibre were united in a single mass, or on a rigid framework.

For the protection of fortresses, such guns were employed in Flanders in 1347; four breech-loading tubes of small calibre being placed on a two-wheeled cart, with their muzzles protruding through a wooden screen, protected by a *chevaux-de-frise.*†

Andrea Cattaro mentions a machine used in Italy in the 14th century‡ (against the people of Carrara), which consisted of a carriage having 144 small bombards (*bombardelles*) ranged in rows of 12, three of which rows could be fired at once, and so 36 balls (about the size of an egg) discharged at a time. The carriage was drawn by four horses, and three men were sufficient for loading and firing the 144 bombardelles.

At the battle of Tongres, again, in the year 1408, a number of ribaudequins, or tube guns, were used, but apparently with little effect; and three years later we find that the Duke of Burgundy's army of 40,000 men had 2000 organ guns, besides cannon.§

These weapons were originally of clumsy construction, and could not be discharged with rapidity. Towards the end of the 15th century, however, more efficient organ guns were taken into the field,"‖ but wheeled carriages, strong enough to resist the recoil of a field piece, and yet fairly mobile, were constructed about this period; so that Francis I., when invading Italy in 1515, though he carried organ guns with him, also took a number of field pieces. As the latter improved in mobility, the use of tube guns was gradually given up, and after the 16th century their employment in war seems to have been exceptional.

Ufano, indeed, writing in 1621,¶ gives a drawing of a four-tubed gun mounted on a field carriage as a weapon then in use, and we find similar machine guns employed by the Scotch in 1644, during our civil war. At the battle of Copredy Bridge, fought in that year, the Cavaliers captured "two barricadoes of wood, which were drawn upon wheels, and in each seven small brass and leather cannon charged with case."*

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* M. Remi ("Memoires de l'Artillerie,") defines an orgue as "a machine composed of several musquet barrels fastened together, and used for the defence of breaches and entrenchments, on account of the possibility of firing from them several shots at once."

† Citadella's description quoted by Chesney ("Observations on Fire-arms," p. 57). Models of such guns may be seen at the R.M. Repository, Woolwich.

‡ "Ancient Cannon in Europe," by Captain H. Brackenbury. ("Proceedings R.A. Institution," Vol. V., p. 33).

§ "Etudes sur l'avenir de l'Artillerie," by the Emperor Napoleon III.

‖ Specimens of such weapons exist in Germany—*e.g.*, Weigel, describing in 1698 the contents of the arsenal at Nuremburg, mentions tube guns with 33 barrels, termed "Todten-orgels," on account of their deadly effect.—"Ancient Cannon in Europe," by Captain H. Brackenbury, R.A., ("Proceedings R.A. Institution," Vol. V., p. 29).

¶ "Artillerie," par Diego Ufano. Zutphen, 1621. Plate *β*, opp. Chap. xxiii.

For some two centuries from that date, we hear little more of many-barrelled guns, until the Crimean War woke up the spirit of destructive invention. The science of mechanism had made gigantic strides since the 17th century, and although metallic cartridges were not yet used, rifling had come into vogue.

In 1853, Mr. S. A. Goddard invented a rifle battery of 36 barrels, combined together and mounted on wheels. Later on, Sir J. Scott Lillie and others brought to the notice of Government several natures of compound guns, on frames or wheels. None of these inventions were considered applicable for general service, nor was it until the great Secession War in America of 1860 that machine guns were again used in the field.

An engine of war, called a Requa rifle battery, was employed at the siege of Charleston. It consisted of 25 rifled barrels, each 2 ft. long, arranged horizontally on an iron frame upon a field carriage, and it weighed altogether about 1400 lbs. It could fire at the rate of 175 shots per minute.†

General Gilmore, commanding U.S. forces, reported with regard to this weapon:—"I feel quite satisfied that it is adapted to the defence of earthworks, particularly in a flat country like this, where the horizontal line of dispersion afforded by the fire of this piece is more effective than the cone of dispersion of the howitzer."

Notwithstanding this report, they did not come into favour, and machine guns, somewhat resembling the Gatling, exhibited to General M'Clellan (when before Richmond, in 1862) were contemptuously called "coffee grinders," and never brought to the front. Their mechanism was still imperfect, while the wooded country in which most of the fighting took place was not suited for their employment. Otherwise, the Americans would certainly have made more use of them in that war—a war in which, as Rossel says, "each new means was tried, every old one had its turn; where, as soon as an operation of war was known and appreciated, its use was pushed to an extreme."‡

Subsequently to 1860, many new machine guns were brought to the notice of our War Office—*e.g.*, those of Colonel Martin, 4th King's Own, in 1860; of Mr. Palmer, U.S., and General Vandenburgh, also an American, in 1862-3; of Mr. Dupuis, and Captain Warlow, R.A., in 1866. Though some were ingenious, none of these machines were worth much experiment.

In 1869, the question of such weapons was seriously taken up by different nations. The United States Government ordered 100 Gatling guns, to be used for flank defences, and occasionally as field artillery;

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* Clarendon, p. 522, quoted by Lieut. Hime, R.A., in his "Field Artillery of the Great Rebellion." ("Proceedings R.A. Institution," Vol. VI., p. 301).

The nature of tube was no doubt copied from the leather and brass field guns employed by Gustavus Adolphus, under whom many Scotchmen fought in the Thirty Years' War.

† For a full description of this weapon, *vide* Owen's "Modern Artillery," p. 296.

‡ The "Art of War," by L. N. Rossel, Captain of Engineers.

while several European states had one or two Montigny mitrailleurs manufactured for trial.*

In 1867, our Ordnance Select Committee tried a Gatling gun against a 9-pr. R.B.L. gun, with very fair results for the former; while in 1869, as Major Fosbery had reported favourably to the India Office upon the Montigny, and the French Government were making a similar weapon in considerable numbers, it was decided to carry out further trials, both with the Montigny and the Gatling gun, which latter had been much improved by Mr. Broadwell since the experiments of 1869.†

In August, 1870, a Special Committee carried out these further trials, which resulted in the preference being given to the Gatling gun, a small number of which the Committee recommended should be at once purchased.

Their report was made in November, 1870, at which date a full knowledge had not been obtained of the effects of the mitrailleurs used in the Franco-German war of that year. Twelve Gatling guns, however, of small calibre, for land service, and 24 of medium, together with 12 of small size, for sea service, were ordered as a tentative measure, until further experience was gained.

In November, 1871, the Special Committee above mentioned having prosecuted further enquiry as to the intentions of foreign Governments regarding machine guns, and having examined a number of officers who were present with French or German armies during the war, made a second report, in which they adhered to their former opinion, recommending the adoption of the larger Gatling gun of 0·65-in. bore for coast defences and naval service, and the smaller of 0·45-in. calibre for field purposes.

As already mentioned, a small number of these guns had been ordered in 1870, and it was thought advisable, before manufacturing any more, that these should be thoroughly tried in the service.

This course seems to have been a wise one; for according to the report of the Swedo-Norwegian Commission upon Mitrailleurs, which is dated November, 1872, a machine gun superior in almost every particular to our service Gatling has been invented by certain Swedish patentees.‡

We have now run briefly through the history of compound and machine guns of the past, and further pointed out the various stages of enquiry which led to the introduction into our service (in 1870) of the few we at present possess.

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* In 1867, our military *attaché* at Paris forwarded a battery gun invented by a Mr. Mouceux, consisting of 21 barrels, in three tiers. This was inferior to the Gatling and Palmer guns. In the same year, Her Majesty's minister at Brussels called attention to the manufacture of the Montigny mitrailleurs. In 1868, also, a rifle battery, invented by Colonel Claxton, was submitted for trial. This consisted of 8, 10, or 20 barrels, to be fired by pairs. It did not appear so good an arm as the Montigny.

† Between July and November 1870, numerous inventions, or supposed inventions, were submitted for trial, but were found much inferior to the Gatling. Some of these conceptions were rather extravagant—*e.g.*, one gentleman proposed a gun, to the muzzle of which was to be fixed a "spreader," resembling the "rose" of a garden hose. Through this small shot were to be discharged from the gun!

‡ Since this was written, further report on the mitrailleur in question has been made by a French Committee, who do not view it so favourably. (*Vide* p. 28).

Let us see what other nations have done in the matter.

In 1867, while Europe was yet troubled at the great catastrophe of Sadowa, and France saw in Prussia her future foe, a Universal Exhibition was held in Paris. Midst the triumphs of art and commercial industry there displayed, might be observed specimens of the arms used by different countries, among which was a Gatling gun, sent over from America. This attracted the attention of the late Emperor Napoleon III., and it was taken out of the Exhibition by order of the French Government and subjected to a series of trials at Versailles, at most of which the Emperor assisted personally—so great an interest did he take in the proceedings.

The Gatling of that day, however, showed so many imperfections, that the French, as we have already seen, manufactured a mitrailleuse on the Montigny type. Much mystery was observed about this weapon, considerable numbers of which were made—so many, indeed, that the French army, at the commencement of the war of 1870, possessed 190 of these machine guns as part of its armament. As the war progressed, and new arms were required for the mobilised peasants brought into the field, other descriptions of mitrailleuses, made principally in America, were also used by the French.*

This nation still keeps as service armament the so-called French mitrailleur, and if we may judge by the enthusiastic cheers which greeted the appearance of the mitrailleur batteries the other day, at the great review on the Champ de Mars, France still retains its faith in the value of this particular weapon.

It may be mentioned that the French mitrailleur is heavy, requiring six horses for its draught. The barrels are enclosed within a bronze casing, which gives it much the appearance of a field gun.

In Prussia, both Montigny and Gatling mitrailleurs were tried in the year 1869, in the presence of the King; but as it was thought that the results gained by their use were not adequate to "the *personnel* and *matériel* required in serving them," they were not approved of.

With the exception of one battery of revolver cannon on the Feldl system, made during the war,† no machine guns have been made for this power; but we must remember that large numbers of the French mitrailleurs captured in 1870 are in her possession. Some of these were tried, indeed, at Berlin, in 1871, and pronounced superior both to the Gatling and Montigny guns—an admirable conclusion to arrive at as far as economy is concerned, but one scarcely borne out by unprejudiced evidence.

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* Some Gatlings were used with General Chanzy's army, while the army of the north, under General Faidherbe, had a few Claxton guns. This difference in nature of machine guns used accounts for certain discrepancies in evidence.

† These are no longer in the Bavarian armament. (*Vide* "Revue de l'Artillerie," Tom. II., p. 515, September 1873).

We may therefore regard the French pattern of mitrailleur as the service weapon of Prussia; for it is believed that she has not manufactured any, nor does it appear likely that she will do so at present.

Russia possesses a great number of mitrailleurs. Besides a certain proportion for her fortresses, she has about 400 in the armament of her field artillery. For the latter service, she employs the Nobel machine gun—a species of Gatling, with certain alterations on the plan proposed by General Gorloff.

The Swedo-Norwegian report, already quoted, states that these alterations are by no means improvements on the original.

Austro-Hungary has adopted the principle of Christophe and Montigny in her mitrailleuses. This, like the French, is cased in bronze, and much resembles a field gun as to exterior. It requires four horses for draught, and four also for that of its ammunition wagon, on which some of the detachment are carried.

About 100 of these have been made, and distributed amongst the Hungarian Honved regiments. None have been issued to the regular army.

Spain employs machine guns as part of her field equipment, having in each brigade of artillery one battery of six mitrailleuses.

Turkey also possesses a number of mitrailleuses made, like our own, on the Gatling principle.

America, as we know, uses the Gatling, which was invented by one of her citizens of that name. The pattern used there differs from ours in many minor points.

For service with her troops on the Indian frontier, 50 Gatlings have been made.

In 1873–4 extensive experimental practice was carried on in America between mitrailleurs and field and siege guns, with a view to ascertain the value of this weapon for fortress purposes; and in consequence of the results, the Secretary of State for War recommended to Congress that 209 Gatlings should be purchased, for the armament of flanks in various fortresses. These were to be in position by the 1st July, 1874.*

A regular system of drill for this arm will be found in the "Army and Navy Journal," New York, of 20th June, 1874. (*Vide* our own "Broad Arrow" newspaper of 27th June, 1874).

In the kingdom of Sweden and Norway a Commission has lately investigated the subject, and, according to their report, a species of machine gun invented by Messrs. Winborg and Palmcrantz is likely to be adopted there. It seems to be in some points superior to any existing nature of this weapon.

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* The Americans seem to have a most excellent cartridge for their Gatling. Trials were carried out in October, 1873, to prove the strength of some new metallic cartridges (by U.S. Cartridge Company, Lowell) recently adopted, and also to test the power and endurance of the Gatling of 0·5-in. calibre.

On the 23rd October 30,000 rounds were fired from one Gatling gun, and on the 24th 64,000 more from the same gun. No injury was caused to the barrels, while it was found that after 4000 to 5000 rounds had been fired, the fouling did not increase. For some time the rapidity of fire was as great as 400 rounds per minute. The cartridges stood well, only one failing. There was no escape of gas, nor difficulty in extraction.

A six-barrelled machine gun, termed the "Hotchkiss revolver cannon," has lately been experimented with in Germany. It is meant to fire small shells weighing, when full, about 1½ lbs., with percussion fuze. It outwardly resembles a Gatling, but has only one lock, opposite to which each barrel is brought in turn.

EMPLOYMENT OF MACHINE GUNS, AND THEIR ADVANTAGES GENERALLY.

We now come to the more interesting parts of our subject—viz., the employment of machine guns of the present day, the effects given by them in actual warfare, the reasons for and against their employment, and also the question of their tactical use, and the organisation necessary, should they be taken into the field.*

When a new invention, or an old one revived, is brought to public notice, we invariably find that on the one hand it is unduly extolled, and on the other decried, without much regard to its utility. Such was the case with the mitrailleur.

Some men—ardent inventors, as a rule—supposed that the introduction of the rifle battery gun would alter old conditions of attack and defence. As an example of this we may take the following passage, quoted by Major Fosbery, *à propos* of mitrailleurs:—"Power will no longer be exclusively on the side of the big battalions; but as machinery has rendered industry rich and prosperous, so now, whilst diminishing, or at least without increasing, a war expenditure, it is about to render small peoples and little states as powerful for defence as are the great for attack."

Mr. Gatling wrote a pamphlet about his gun, in which he urged its claims as compared with infantry. He considered it to be a means of revolutionising, in a great degree, the present modes of warfare. A few men, he stated, furnished with these death-dealing engines, would be able to defeat thousands armed with ordinary weapons, and consequently their use would in a great degree supersede the use of large armies.

This reminds one of the old cartoon in "Punch," where the soldiers of opposing forces amuse themselves with cards and dominoes, while automatic fire-arms thunder death and destruction at one another.

On the other hand, prior to 1870, many laughed at the very idea of using such weapons; and the Prussians, in particular, spoke slightingly of arms which they knew their probable antagonist, France, had largely adopted. While the Franco-German war lasted, it was almost necessary for the Prussian staff to decry their powers, and to disabuse the minds of their men of an exaggerated fear regarding the destructive effects of the mitrailleurs, which had been much vaunted by the French.

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* Every machine gun now made would probably be used for much the same ends, whatever the details of its construction; and as these details affect but little the broad questions as to how and where such weapons should be employed, they have not been entered into here, but are given in Part II., which follows.

The experience, however, which was gained during the war of 1870, and careful official investigations made since that time by the War Departments of various powers, have cleared up the subject very much, and enable us now to form a fair estimate as to the value of machine guns, and to see more plainly the uses to which they should be applied.

We may say with some certainty that their employment will, in general, be restricted to the following:—

I. *For Field Service.*—An addition of a light nature in small numbers to the reserve artillery of an army, for increasing the fire of infantry at critical moments,* and for the *defence* of bridges, villages, field entrenchments, &c.

II. *For Fortresses or Siege Works.*—In caponnières, têtes du pont, breaches, and flank defence generally, and for use in advanced trenches.

III. *For Naval Purposes.*—Firing from ships' tops, and in boat operations.

To understand how these conclusions have been arrived at, we must take in detail the several modes of employment possible.

I.—EMPLOYMENT IN THE FIELD.

In the field, mitrailleurs would have to oppose either artillery, cavalry, or infantry.

To be effective against field guns they must have long range, be comparatively heavy, and carry such a weight of ammunition that the number of horses required would be almost the same as that used with a field gun; while for many purposes they would be quite powerless—for instance, against walls, stockades, entrenchments, or cover of almost any kind.

Against the horses and men of artillery exposed within their range such mitrailleurs might indeed be formidable; but that would not make up for their impotence in shell fire for destroying villages or *matériel*, blowing up ammunition wagons, driving troops out of cover, &c.

General Walker, who accompanied the Prussians, states that "the French mitrailleurs were invariably driven off the field the moment they showed themselves so that the Prussian artillery could get at them." (The best range for the Prussian guns was 1800 yds.)

Captain Gurdon, R.N., who was with the French army of the Loire, says that, when opposed to artillery, mitrailleurs always had the worst of it. He only saw one case when they had any effect upon the former—"at the battle of St. Jean-sur-Eroe, where three Prussian 12-prs. came down a road and opened fire upon us at a distance of 2400 yds. We brought four mitrailleurs against them, and after a quarter of an hour these guns limbered up, evidently having some of their horses and guns disabled, and retired another 300 yds. to the rear."*

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* As batteries of position would be used to strengthen fire of field guns.

The Special Committee (of which Colonel Wray was President), in their report of 1870, state:—"We are also impressed with the effect produced by the medium-sized Gatling—0·65-in. calibre—at long ranges, as compared with that of a field gun; but looking at the weight of ammunition required to produce this effect, and to the exceptional conditions under which the larger Gatling could be used with advantage in the field, we are satisfied that a gun is far preferable at long ranges, and consequently we do not recommend the introduction of the larger description of Gatling for land service. Except against an enemy in the open, the fire of a mitrailleur is comparatively worthless; whereas artillery fire will search out an enemy from almost any position, whether covered by trees, brushwood, earthworks, or houses, and at distances far beyond the range of a mitrailleur."

Notwithstanding the many advantages claimed by Mr. Gatling and others† for the use of a far-ranging mitrailleur, the reasons to the contrary seem conclusive; and we find that the opinion of foreign officers coincides with those of our own Committee as to the advisability of not adopting such a weapon for service in the field to cope with artillery at long ranges.‡

For use against cavalry and infantry, however, a lighter machine gun, firing S.A. ammunition,§ might be employed, and would in certain cases be very useful. So much had been expected of their new arm by the French, that when their armies were vanquished by the victorious Prussians, the mitrailleurs, like all else concerned on the losing side, did not get the credit due to them. Those which they employed were so heavy as to require six horses, while the few taken into the field by the Bavarians under Von der Tann were very defective in mechanism.

Notwithstanding this, however, and the imperfect knowledge then possessed as to their proper tactical employment, we find that they proved at times of great service.

Captain H. Brackenbury, R.A., mentions several instances:—"At the battle of Rezonville," he says, "we have very plain evidence as to whether the French considered the mitrailleuses to be more effective than guns in certain positions, by this fact—that Marshal Bazaine, who was there on the spot himself (near a ravine close to the Bois de Oignons), had plenty of guns under his hand, but had only two batteries of mitrailleuses. To defend the head of this ravine (and this was after having seen previous battles) he brought up his mitrailleuses. Any one who has seen that battle-field, who has seen the way in which the graves are at this point piled almost one upon another, will see how awful the slaughter must have been; and it was due, practically, entirely to these mitrailleuses."

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* The French mitrailleurs, we must remember, were heavy ones, having six horses and considerable range.

† These may be summed up as—(1) Equal range, with greater accuracy and precision than field pieces. (2) Rapidity and continuity of fire. (3) No recoil; therefore no re-sighting or re-laying necessary. (4) Lightness. (5) Greater power of richochet fire. (6) Economy in money, horses, and men.

‡ *Vide* American report of this year.

§ It is not absolutely necessary, of course, that the ammunition used should be the same as that used by the infantry, but still it is very desirable. Neither with our own nor the French machine gun can service S.A. ammunition be used, at present.

"There is," he also says, "another peculiar case, and that is on the western side of the battle-field of Sedan. On the heights, close to Floeing, there was placed a battery of mitrailleuses. There is, opposite to that, a round hill with wood on the top; and out of this wood and from behind this hill came the Prussian columns. As they came out they were swept down by these mitrailleuses, and they did not succeed. They could not make any progress, but were obliged to go back again, and go round on the reverse slope of the hill, checked by the mitrailleuse."

Another example is given by him of the remarkable work sometimes done by the mitrailleuses, in the defence of a railway bridge at Bazeilles:—"The Bavarian columns came down and endeavoured to cross that railway bridge, preceded, of course, by their skirmishers. Two mitrailleuses only, I believe, were placed behind a garden wall, and they simply swept the bridge, so that the Bavarians could not pass it."

Mr. Winn thus describes the effects of mitrailleur fire at Gravelotte, upon a body of German cavalry:—"It was about 3 o'clock that Malmaison was taken by our (the German) troops, and it was on some Uhlans who tried to cut off the retreat of some Voltigeurs that the mitrailleur so terribly vindicated its character for destruction. A squadron rode forward with its usual pride and confidence; we heard the growl of this truly infernal machine; we saw an unwonted confusion in the Lancers' ranks; they wheeled and retired, leaving behind them 32 horses and as many men. They had unwittingly crossed the fatal line of fire, and had they remained to rescue their comrades, three minutes would have sufficed to put them in the same helpless condition. We had gone forward to the extreme point of the glen, and with our glasses could plainly see the gunners as they placed the fatal plate in the hydra-mouthed cannon."

Colonel Fielding again instances the effects produced at the second battle of Beaugency on a Prussian column of infantry, where clear gaps were cut through one of its angles. The same effect, he thinks, could not have been produced by infantry, as the time necessarily spent in deployment would have given warning to the approaching column. He considers "the proper use of mitrailleurs to be as representing a certain number of infantry, for which there is not room on the ground, suddenly placed forward at the proper moment, at a decisive point, to bring a crushing fire on the enemy."

Captain Knollys, R.A., writing of the battle of Sedan, narrates the effect produced by six mitrailleurs, which were entrenched, and played with deadly effect on the Prussians, who attempted to cross a valley intervening between them and some rising ground about 900 yds. distant. "The numerous Prussian graves on the slope of the Mamelon attest the severe loss they suffered," he says, and afterwards adds—

"In this solitary instance* the effects of the mitrailleurs were confessedly superior to any which could have been inflicted by common shell."

To go through all the evidence taken by Colonel Wray's Committee of 1870–1 of officers who actually saw mitrailleurs used in the field would encroach too much on our space. It is thus summed up by Colonel Fletcher (one of the Committee):—

1. The French officers, and those who witnessed the campaign from the French side, were generally in favour of the employment of mitrailleurs in the field.
2. The Prussian staff disapproved of their introduction into the service.†
3. English officers who were present with the German army, with one exception, considered that for certain purposes they might prove useful adjuncts to field artillery.

Colonel Wray's Committee carried on exhaustive trials between the 9-pr. R.M.L. gun, firing shrapnel, a small (0·45-in. bore) Gatling gun, and six Guardsmen, armed with the Martini-Henry. In a series of eleven trials, where the firing took place at ranges from 300 to 1200 yds., and under various conditions as to time and distance, the Gatling made 2699 hits, the 9-pr. gun 1620, and the Martini-Henry 718.‡ (*Vide* Appendix for tables of practice).

This, of course, merely proved that under certain circumstances the fire of a mitrailleur would be very deadly beyond the range of case shot; but it must also be borne in mind that with known short ranges this fire is certain, while shell fire is always more or less uncertain.

With these facts and this evidence before them, the Committee, in their final report, laid down distinctly "that the mitrailleurs should be treated purely as defensive weapons, and that they should in general be entrenched, and kept as far as possible masked from artillery fire; that the so-called small Gatling of 0·45-in. calibre—of which the destructive effect against troops in the open, at ranges up to 1400 yds., is estimated as being nearly three times that of the 9-pr. field gun—should be lightened, so as to be easily drawn, with its carriage and ammunition, by two horses, and on an emergency by one." Also "that the field artillery should not be reduced by a single man or horse for the sake of substituting mitrailleurs."

To assist in defending such positions as villages, field entrenchments, &c., the Committee considered that the small Gatling would be found invaluable.

In these opinions we find by their report that the Swedo-Norwegian Commission agree. They say:—"The Committee believe that this arm is chiefly of a defensive nature, which nevertheless does not diminish its importance or merit, even in field warfare;" adding afterwards that they "cannot too strongly insist on the importance of not confounding mitrailleurs with artillery, as much on account of their effect, as the proper nature of their employment."

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* This officer was on the German side of the theatre of operations.

† We must remember that the Prussians had no opportunity for testing their merits for defensive purposes, wherein their value seems principally to lie.

‡ This was on level and fairly hard ground.

Our first conclusion (p. 8), seems to be borne out, in so far as mitrailleurs have been shown to be terrible weapons under certain circumstances. It has been shown also that it would be most unadvisable to replace even a single field gun by such a machine. But then comes the question, whether by taking into the field a certain proportion of this fire-arm we gain "an advantage commensurate with the additional expense and trouble, and the addition to the *impedimenta* of an army."

This question cannot well be answered without considering the proper tactical use of mitrailleurs, and the organisation necessary for field service.

Tactical Use of Mitrailleurs.

In answer to questions on the subject, General Walker, who was with the Prussians throughout the war, says:—"Where is the tactical place of the mitrailleur? I believe the mitrailleur likely to prove effective as a gun of position in street fighting, in the defence of villages, of defiles, and in the flanks of permanent works; but I could not consent to spare one single field gun from the proportion of artillery adopted in this country as proper for field operations for the purpose of replacing it by a mitrailleur. I think that the mitrailleur might prove very effective if employed against a half-disciplined enemy, inadequately supplied with field artillery; but its effectiveness presupposes that the opponent is obliged to advance on the narrow front which is covered by its range."

Colonel Hamley, critically considering the subject, writes:—

"The question of employing the mitrailleuse may, in a great measure, be argued without further reference to the experience of war, because all the circumstances on which efficiency depends have been ascertained by experiment and by the testimony of observers, except one—namely, the frequency with which opportunities for its effective action may be expected to occur; and even that may be fairly estimated without actual experience.

"In the case of an army about to attack, it is more than ever desirable to precede the advance of troops by a concentrated fire of artillery. If Gatling mitrailleuses were used for this purpose, they must move forward to within 1200 yds. of the enemy's line. As they could not always—perhaps not often—choose sheltered ground for their position, they would, while taking it up, and afterwards, be exposed to the enemy's artillery at easy range. Even if protected from this, their own fire would generally be directed on troops secured from it, either by obstacles already existing, or by those constructed for the purpose. For this end, therefore, they may be pronounced absolutely useless, and must be left out of the account in considering *offensive* operations.

"It is perhaps partly on this ground that the Prussians, whose tactics have been invariably offensive, have rejected them.

"For defensive purposes, in order to compare them with field guns, the effect on the enemy must be estimated, not over the limited range within which the Gatling is effective, but over the whole extent of ground on which the enemy would be exposed to projectiles when advancing. This would, on open ground, be three times the range of the Gatling; and the total loss caused by a field gun throughout the advance would probably far exceed that inflicted by the mitrailleuse within its own more limited range.

"But, on the other hand, many cases must arise in war in which the long range of the field gun would be superfluous, while the mitrailleuse could be employed under its own conditions of effectiveness. In all countries not absolutely flat, troops may often engage with no greater distance than 1200 yds. between the hostile forces. Thus the French troops attacking Hougomont would have been always under the effective fire of Gatlings from the British position.

"In broken or mountainous ground, there will always be parts of the field where the assailant's troops will be sheltered from fire up to short range, and would only begin to suffer loss on issuing from their shelter. Thus, in all the *northern* part of the field of Solferino, the defenders (had they prepared the position) might have effectually used mitrailleurs, but not so in the plain forming the southern part of the field.

"It may therefore be fairly inferred that it would be quite inexpedient to diminish the field artillery of an English army, in a foreign war, by supplying it with weapons which, if present at all with marching and manœuvring troops, must to that extent occupy the place of guns. But there are cases in which *protected* Gatlings would bring the most effective possible fire to bear on an advancing enemy, especially if approaching on a narrow front—as when issuing from a village, or moving in a hollow road, or crossing a bridge, and in which guns would be much better employed elsewhere. Therefore, for *home* defence, or when holding selected positions, there would often be opportunities for employing them in preference to long-ranging artillery. For such circumstances, therefore—namely, the defence of this country, or when it may be foreseen that our troops will be engaged on the defensive—as to cover an embarkation—a certain supply of Gatlings, say one to twelve guns, would be of great value if kept in the depôts, and only moved into position when the time for using them had come."

We have here an admirable summary of the tactical uses of mitrailleurs, as might be expected from the writer.

It is clear that machine guns would only be used for defence; as Captain H. Brackenbury well puts the question:—"What do we see in all those battle-fields but one single plan of attack? First the infantry is utterly demoralised by the crushing fire of a mass of artillery concentrated on it; then masses of skirmishers or columns are sent up to attack. What can you do with the mitrailleuses? They are of no value in the attack; but in defence, in certain positions, I believe them to be invaluable, and I hope to see them introduced into our army, but not hampering the infantry by being rigidly attached to them."

For bush and mountain warfare the mitrailleur[*] does not seem well adapted, except perhaps for defence of field works or stockades, if the ground be sufficiently clear.[†] Some Gatling guns of 0·45-in. bore were sent out to the coast of Africa for service in the Ashantee War; but, so far as we have heard, these have not proved so useful[‡] as the small guns,[§] which have also been employed there.

However portable such arms may be made, they would be useless against the weakest defences, as well as in broken rocky ground, where the moral effect produced, even by a small shell, is great, particularly when nations more or less uncivilised are in question.

It may be remarked that mitrailleurs require flank support by infantry, when in action, even more than artillery does. Both at Paris and Le Mans the Prussian skirmishers captured mitrailleurs by avoiding their direct fire, advancing on their flank and then closing in.

Conceding that mitrailleurs should be brought into the field for defensive purposes, we have to settle whether they should be attached to infantry or cavalry, or form part of the artillery of an army. Our own Committee and the military opinion of most other nations are in favour of making them a supplementary part of the artillery force, as has been the case, so far, when they have been used in actual war.

To attach machine guns to infantry would hamper the movements of the latter, who would also, as a rule, select ground for advance not suitable to wheeled carriages. The Austro-Hungarian Government, indeed, have attached mitrailleurs to regiments of militia, to give moral and material support; but such a scheme seems radically wrong. The duties required of the *personnel* of mitrailleur batteries are quite distinct from those of infantry, and both officers and men should be highly trained in the tactical use of their particular arm.

It has been suggested that mitrailleurs should be attached to each cavalry regiment for use with piquets, and in covering an advance or retreat. Cavalry, it is said, act principally in an open country, where mitrailleurs would be specially effective. But, on the other hand, in country sufficiently open for cavalry operations, the probability is that horse artillery, with superior range, would soon silence the mitrailleurs.*

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[*] A small Gatling, to fire from a tripod, was proposed for mountain warfare, but it turned out a failure when tried.

[†] We find, indeed, that 50 Gatling guns of 0·45-in. bore have been made in the United States for service with troops on the frontier. The Director of Ordnance, in his Report of 1873 (to Secretary of State for War) says, regarding them:—"These guns are of such dimensions and weights as to be easily transported on pack animals. Their efficiency can only be tested by use; but it is thought they will be far more effective in Indian warfare than the mountain howitzer heretofore in use." Whether this opinion is correct or not must depend on the nature of the country operated in. On the flat western prairies they might be very effective.

[‡] Major Rait, C.B., has informed me, since the above was written, that these mitrailleurs were found cumbersome, and so top-heavy on the rough road traversed, that the fittings, sights, &c., had to be removed for travelling. They were not taken further than the Prah. These Gatlings were mounted on special carriages.

[§] 7-pr. steel R.M.L. (Some 4½-in. bronze howitzers, S.B., weighing 280 lbs., were found to be too heavy for carriage).

The duties of cavalry soldiers are sufficiently arduous as it is, and to add to them others quite foreign to their own would not be at all advisable.

Organisation for Field Service.

We find that the French used batteries composed of six mitrailleurs, while the two Bavarian batteries employed were composed of four each. These mitrailleurs, however, required six horses for draught, and also more *personnel* than would be used with our Gatling, for instance.

Russia has batteries of eight mitrailleurs, and Spain of six.

Colonel Wray's Committee proposed that twelve Gatling guns should constitute a battery, in accordance with the detail given in the Appendix.

It will be seen that on the line of march the space occupied by such a battery, as compared with that taken up by a 9-pr. R.M.L. gun, would be 156 instead of 353 yds.

The number and ranks of the officers would be similar to those in a field battery; but there seems no necessity for this. Four mitrailleurs may be looked upon as the largest number likely to be employed in any particular case. The organisation proposed by the Committee is stated, indeed, to be meant "for organisation, and not for tactical purposes." Would it not be better to have four mitrailleurs, in the charge of one Captain and one Subaltern officer, as the tactical unit? Two of these, if necessary, might be united for larger administrative purposes under a Major, or four under a Lieut.-Colonel; but it seems to me that the tactical unit should, as in the case of field artillery, be also thoroughly recognised in organisation.

The Swedo-Norwegian Committee say:—"We consider that a mitrailleuse battery should consist of four pieces. Doubtless two mitrailleuses (half a battery) could alone strongly reinforce a position; but it would be preferable, in a case of importance, that a whole battery should be detailed, in order that the tenure of a position might not be imperilled by the dismounting of one or two mitrailleuses. On the other hand, circumstances are not likely to arise when the employment of more than four mitrailleuses would be necessary."

As the mitrailleur can only be used advantageously for defensive tactics—and that on exceptional occasions, when the ground in front is clear of cover—all will agree, I think, that the reserve of a division is the proper place for batteries of this arm, if it be taken into the field.†

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* Count Thürheim claims to have driven back a battery of French artillery with his revolver cannon, or mitrailleurs, at Culmiers, but the practice of the battery was apparently very bad.

† The Special Committee of 1870-1 recommend "that they should be kept with the reserves, for the express purpose of increasing infantry fire at critical moments, in the same way that guns of position are used for strengthening the fire of field artillery."

The Swedo-Norwegian Committee say:—"It follows, from the duties assigned to the mitrailleurs, that they should be under the command of the divisional chiefs; that they should form part of the divisional reserve, and not be attached to brigades or battalions except the latter are exceptionally employed under circumstances when mitrailleurs might appear necessary."

The proportion of field artillery (including reserves)—at most 3 guns per 1000 men—is certainly calculated as being the maximum which can accompany an army without hampering and embarrassing the latter by excess of *impedimenta;* but we have seen that it is proposed to use only two horses for the carriage of a Gatling, so that the space occupied on the line of march would be very small, and it appears that we might add with advantage a small number, say twelve (or even more) Gatling guns to the proportion of artillery—seventy-two guns*—laid down for an Army Corps of 30,000 men, to be attached to reserve of same, or distributed amongst divisional reserves.

It must be remembered, however, that great care and caution have to be exercised in the introduction into our field equipment of an arm of such limited use.

If we do employ any, they should be the very best obtainable; so that the wisest policy is not to manufacture many till greater mobility than our service Gatlings possess, as well as the other essentials mentioned further on, have been attained.

As soon as this is the case, the necessary number for the reserve of our army can, with the manufacturing capabilities of this country, be produced at very short notice.

II.—Employment of Machine Guns for Fortresses or Siege Works.

There is very little difference of opinion as to this mode of employing machine guns. Where space is limited, the front clear, and range known—as in permanent works—these weapons would be most useful in caponnières, counterscarp galleries, &c., for the defence of ditches, as well as of the short flanks of works,† while in a breach their effects would be most formidable.

	R.H.A. Guns.	Field Battery.	Total.
*Reserve	6	18	24
3 Infantry divisions (each 12)	—	36	36
1 Brigade cavalry	12	—	12
	18	54	72

† The Swedo-Norwegian Committee say:—"In warfare of position, or fortresses, these arms have so great and so evident an importance that opinions cannot differ thereon." The Americans carried on exhaustive trials last year between Gatling guns, field guns, and 8-in. siege howitzers; and the report of the Board of officers concerned was strongly in favour of using some of these weapons for flanks of works. In consequence, the Secretary of State for War has recommended to Congress the appropriation of 292,600 dols. for the immediate purchase of 209 Gatling guns and carriages, to be in position by the 1st July, 1874. Another Special Board, U.S. army, reporting as to advantages of mitrailleurs in defending short flanks, say:—"There can be no question that the great volume of fire of the 8-in. howitzer (1173 balls discharged in one minute, or double that number if necessary), would prove irresistible on the short lines of our permanent fortifications. Besides, these guns admit of the use of shells when needed." In cases, however, of a simultaneous attack on the curtain and faces of adjacent bastions, they go on to say, "it would be impossible to serve the opposite howitzers with the freedom a good defence would require," on account of the risk to gunners in opposite casemate. The Board therefore recommended one Gatling gun "for each flank of casemated forts, even to the displacement of the howitzer when there is but one flank embrasure, if the scarp can be readily approached, and if there be a line of embrasures raised but a few feet above the ground." (For trial practice, *vide* Appendix).

Colonel Wray's Committee recommend the introduction of the heavy Gatling gun of 0·65-in. bore for coast defences; considering that it would prove useful against boat attacks, or for keeping down the fire of ships engaging forts at close quarters or attempting to force a passage, by pouring an incessant fire into their ports.

The best construction of this weapon not having been determined, none have been added, as yet, to the armament of our forts.

From their comparative lightness, and the absence of recoil, they would prove very serviceable weapons in advanced trenches, and doubtless will form an adjunct to siege trains of the future, for repelling sorties, &c.

III.—EMPLOYMENT OF MACHINE GUNS FOR NAVAL PURPOSES.

Here, again, opinion seems unanimous as to the advantages of using mitrailleurs for ships' tops, to repulse boarders, and for boat service in certain cases.

They have not actually been used in naval warfare, so we have nothing but experimental data to go upon.

For covering a landing they would no doubt be useful, should the beach and adjoining country be open—as would usually be the case; though even then they should supplement, and not supersede, the heavier natures of guns used for boat or field marine service. Notwithstanding that great advantage, in a boat, of absence of recoil, their manifold disadvantages must not be lost sight of.

Some officers strongly recommended their employment for boat expeditions up rivers; but, as a rule, they would seem unsuitable weapons for such a service—unless, indeed, the river should be exceptionally open, and not dominated by high banks. Expeditions of this description are usually directed up streams with more or less cover near them; and where this is considerable—as was the case along the Volta, when our gallant Commodore Commerell was wounded the other day—* the smallest gun which could throw a shell into the bush would be better; for what effect can a mitrailleur have against dense jungle?

In our service, twelve of the 0·65-in. bore and a similar number of the 0·45-in. calibre have been ordered for trial by the navy, until the question of the best construction be definitely settled.

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* While reconnoitring this river, on the coast of Africa, during the Ashantee war.

PART II.

CONSTRUCTION OF MACHINE GUNS USED BY DIFFERENT NATIONS.

We may now pass from the more general questions, and study in detail the mitrailleuses used by different powers, and also some at present under trial.

The point to consider is, which nature constructed up to this time seems the best adapted for field service. That once settled, there would be no difficulty in making the necessary alterations to fit the arm for fortress, siege, or naval service, where so great mobility may not be necessary.

Various modes of construction have been tried for the attainment of rapid fire by mitrailleuses. A number of barrels may be fixed in a rigid framework, and loaded and fired by means of a moving lock or locks. This is the construction used with the Swedish mitrailleuse of Palmcrantz, a model of which was exhibited at Vienna.

Other inventors have attempted to utilise the principle of the ordinary revolver, with a single barrel and many rotating locks. As may be imagined, however, this failed when the firing was very rapid, as the barrel became red hot.

The construction most used of late is that in which several rifle barrels are assembled round a common axis. These barrels are either stationary or rotate with the axis. The French as well as the Austrian service mitrailleuses are on the former principle. They are loaded by means of discs or cartridge plates holding as many cartridges as there are barrels. One of these is placed vertically in a slot behind the barrels—much as a vent-piece in an Armstrong gun. This disc is afterwards jammed up against the breech ends of the barrels by means of a lever and screw.

In the Gatling gun—used by ourselves, as well as by Russia, America, &c.—the barrels rotate with their common axis, in a rigid framework, and are accompanied by their locks, which load them, fire, and then extract the empty cartridge-cases.

A disadvantage common to all the systems in use is the complication of the mechanism; nor does it seem probable that this can be easily overcome, looking to the requirements of the weapon.

It will be seen that cams, both in the form of the curved outside edge of a plate, and of that of a slit cut in a plate or lever, play a prominent part in this mechanism.

The principal *desiderata* for the weapons in question, seem to be :—

1. Rapidity of fire (which should reach the rate of 300 or 400 rounds per minute).*

2. The mechanism should not be easily put out of order, even if the rapidity of fire exceed occasionally the normal standard.*

3. The mitrailleur, with a considerable number of rounds (say 4000) should be capable of draught by two horses.*

4. The piece should be readily separated, if necessary, from its carriage; and be capable of conveyance by hand, should the place be inaccessible to horses.* No special tools should be required for this, save a powerful screwdriver or hammer.

5. It should be furnished with automatic apparatus for giving and regulating horizontal spread of bullets, at various angles, and be capable of easy elevation, throughout a sufficient height.*

6. The ammunition used should, if possible, be interchangeable with that of infantry.

7. Two men should be capable of performing all the duties of the piece when under fire.

N.B.—It should be particularly noted that with this weapon some sort of range-finder should be employed, as most strongly recommended by the Committee of 1870–1, who proposed the adoption of that invented by Captain Nolan, R.A. Though it seems advisable that every field gun should be furnished with range-finders, it is possible to find out by trial shots, from a gun, an approximation to the correct range, but not so with mitrailleurs.

The following table partially shows how far the service machine guns of different nations fulfil the above requirements :—

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* These are laid down by the Swedo-Norwegian Committee.

Nation.	Nature of mitrailleuse.	1 Nominal rapidity of fire. Rounds per minute.	2 If mechanism is capable of greater rapidity.	3 Weight.					4 No. of men to carry when dismounted.	5 If capable of lateral spread.	6 Ammunition used.	7 No. of men for service in action.	Range up to	Remarks.
				Gun complete.	Carriage complete.	Limber, empty.	4000 rounds (about).	Total.						
				cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.					yds.	
England	Gatling, 0·65-in. bore.	—	—	7 2 14	7 2 13	—	—	—	?	Yes.	Special.	?	—	For naval and coast service.
〃	〃 0·45-in. 〃	300 to 400	No.	3 3 24	5 2 10	7 0 3	4 0 0	20 2 9	?	Yes.	Special.	2	2400	Up to 1200 yds. produces maximum effect.
Russia	〃 ? 〃	—	No.	1 0 0	12 1 10	9 2 10	?	?	?	Yes.	—	—	—	360 or over in their service for fortresses.
〃	Nobel.	About 300	No.	1 0 0	2 1 8	5 1 4	3 0 8	11 2 20	?	Yes.	Special.	?	1870	For service in the field.
France	The French.	100 to 150	No.	?	?	?	?	?	?	?	Special.	?	?	〃
Austria	Montigny and Christophe.	200	No.	3 2 5	9 3 4	9 1 20	?	?	?	?	Werndl S.A.A.	?	1000	〃
Prussia	The French.	As above	No.	—	—	—	—	—	—	—	—	—	—	〃
Turkey	Gatling.	〃	No.	—	—	—	—	—	—	—	—	—	—	?
America	〃 0·45-in. bore.	—	No.	?	?	?	?	?	?	?	Berdan.	—	—	For flank defence, and frontier war.
Sweden and Norway	Palmcrantz.	400 to 500	No.	2 2 6	2 2 2	?	3 0 0	?	2	?	Special as yet.	1	1400	Only proposed, not adopted.

With reference to the foregoing, and to the details given below, it seems necessary to make some apology for the meagre and insufficient information afforded in the table; and also to explain why full details as to the construction of certain mitrailleuses are given, but few or none as to that of others.

Regarding the table, it has not been found possible, as yet, to fill it in with absolute certainty that the weights, &c., would be correct; and it was therefore thought better to furnish one, incomplete as it is, in hopes of being able to supply the omissions at some future time.

As to the Spanish mitrailleur, though the organisation of their batteries is known, and the weapon is doubtless now being used in the civil war of that unhappy country, yet no details as to its nature, equipment, &c., could be obtained. Probably it is a species of Gatling.

From information received since the table was made out, it appears that the Austrian service Montigny mitrailleuse weighs 6 cwt. 18 lbs. (not 3 cwt. 2 qrs. 5 lbs.), or 1 cwt. more than their 4-pr. field gun, throwing an 8-lb. projectile.

Then, again, as to minutiæ of construction.

Full details as to our service Gatling are given, for reasons sufficiently obvious.

The French mitrailleur, and that of Christophe and Montigny, have been often described elsewhere; and, moreover, their type seems one not likely to be copied again.

The mechanism of the Palmcrantz mitrailleur has been minutely detailed, not only because of the many advantages the weapon itself plainly possesses, but also on account of the novelty of the mechanism, which, though complicated, from the number of parts, is otherwise of much merit.

At present, however, our own Gatling, of a simpler construction though slower in fire, seems a better weapon.

THE GATLING GUN.

This belongs to the description of mitrailleurs where the barrels revolve, and are charged simultaneously. Each barrel has its special lock, which accompanies it during revolution, and is also capable of motion backwards and forwards. It pushes the cartridge into its barrel, then serves as a breech, and afterwards extracts the empty cartridge. Each lock has a striker with spiral spring, and an extractor.

The system is caused to revolve by means of a crank fixed on the right side of the piece.

The following improvements have been made in those of more recent construction :—*

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* Our service Gatlings possess all these improvements, but the Swedo-Norwegian Committee think that if the normal rate of fire is exceeded they are likely to get out of order; and also that the mechanism is too complicated.

Magazines containing 20 to 25 cartridges each, have been replaced by drums containing, with our service arm, 240 rounds.

The spring extractor has been improved, so as to ensure the empty case being withdrawn.

Each lock can be taken out separately, and replaced by a new one.

An automatic "scattering" arrangement has been added, which can be put in gear or not, as required, and which is worked by the crank which moves the system.

300 to 400 rounds per minute can be fired from this mitrailleur.

Two men are sufficient to serve one in action.

We have two natures in our service—the 0·65-in. and the 0·45-in. bore.

Construction in detail. (*Vide Plates I. and III.*)

Ten steel barrels, rifled on the Henry principle, are fixed in a circle round a centre shaft of steel. To this shaft are keyed two gun-metal discs, through one of which the muzzle ends of barrels pass, while their breech ends are screwed into the other.

The shaft itself is fixed in a "gun-frame" (*aa*, Fig. 1) of wrought-iron, made of two bars connected in front of muzzles by a curved cross-piece (*n*, Fig. 1). The rear ends of this gun-frame are connected by screws to a cast-iron box, or "breech-casing" (*C*, Fig. 1), which contains the mechanism. In this casing is a vertical diaphragm, through which the shaft passes towards the breech, and the breech end of the casing is closed by a "cascable-plate" (*D*, Fig. 1) of cast-iron.

Inside the casing, upon the rear end of the shaft, is a small (pinion) worm-wheel (*W*, Fig. 2), which gears into a worm (*f*, Fig. 2) on a crank-shaft or spindle (*gg*, Fig. 2), which passes into the breech-casing on the right side, and at right angles to the main shaft. By turning a crank-handle secured to this spindle, the main shaft and barrels are caused to revolve. When not in use, this handle is pushed in out of the way.

Fastened by screws to the gun-frame, is a "pivot-block" of gun-metal (*p*, Figs. 1 and 3); a pivot (*P*, Fig. 3) passes through this, and into an iron trunnion-plate (*ee*, Figs. 2 and 3), and upon it the system turns when lateral spread of bullets is required.

The trunnion-plate has projections, or trunnions, on which the system revolves for elevation, and is secured at the rear end by a bolt and nut to a locking-bolt plate which fits into an undercut slot in bottom of breech-casing.

When a scattering fire is required, the frame, barrels, &c., turn on this "block" through the required arc by means of an automatic arrangement (*AF*, Fig. 2) worked by the crank-handle before mentioned. When such is not required, the fire is concentrated by putting this arrangement out of gear, and preventing any transverse movement by means of a "locking-bolt" (*l*, Fig. 2) let down into a slot in trunnion-plate at the rear.

On the main shaft in rear of the barrels a cast-iron cylinder, or "cartridge-carrier" (*M*, Fig. 4) is fixed. This has ten longitudinal grooves, corresponding with the ten barrels. A gun-metal cover, or "hopper" (*B*, Figs. 1 and 4), hinged at one side, drops over it. The cover has a longitudinal slot, corresponding to the opening in the "feed drum"* (*T*, Fig. 1), which rests upon the upper surface of "hopper." As each column is exhausted, the drum is turned round by hand until the next one corresponds with opening in hopper.† Through this slot the cartridges drop (as the shaft revolves) into the several grooves, ready to be pushed by the lock-plungers into the barrels corresponding.

In rear of this, and inside the breech-casing, is placed the "lock-chamber," which is keyed to, and revolves with, the main shaft. It is a cylinder of cast-iron, having longitudinal channels through which the "locks" pass.

Upon the main shaft, again, and against the back of the "lock-chamber," is secured a cast-iron "rear guide nut," which keeps the parts firmly together. The locks rest partly upon the outer circumference of this nut; and in the grooves on which they fit, as well as in the channels in lock-chamber, are small slots, in which run studs on the locks, in order to prevent the latter revolving save with the shaft.

Inside the "casing" is a curved gun-metal plate, or cam, by means of which, as the shaft and lock-chamber revolve, the locks themselves are pushed forward or back. A piece of steel is let into the front of this cam, against which the butt of each lock bears at the moment the barrel is fired.

There is also a steel cam, called a cocking-ring, which, as the lock-chamber revolves, draws back and then releases a spiral spring acting on the "firing-pin" or needle of each lock.

The Lock. (*Plate III.*)

The lock consists of a steel tube, or "plunger," about 11½ ins. long, the front end of which, for about 4 ins., is smaller in diameter, and has only a pin-hole running through it.

The remainder is hollow, and slotted out on one side. Its breech end is closed by a steel plug, or "butt," screwed in.

Inside is a steel bolt, or "hammer," having a projection at the side which passes through the slot in the tube, while to the front part of it is attached a firing-pin, or "striker," of steel.

A spiral spring is placed over the hammer, being retained by the "butt."

To the outside of the tube or lock is fixed a steel extractor, having a hook which seizes the rim of cartridge and draws it out as the lock is being withdrawn.

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* This drum is of metal, fits on a pin (*b*, Fig. 4) in centre of hopper, and contains 240 cartridges, in 16 perpendicular columns or channels. It weighs, when full, 50 lbs.

† In the smaller Russian Gatling, used with their batteries of this arm for field service, the drum is turned by an automatic arrangement—an improvement much required in our service Gatling.

Action.

When the gun is in action, five cartridges are always in process of loading, and five are in different stages of extraction. Thus, as the system revolves, cartridges drop from feed-drum through slot in hopper, successively, on the ten grooves in cartridge-carrier; as each lock comes in contact with the cocking-ring, the hammer is drawn back and spring compressed; further rotation brings the lock against the gun-metal cam, which pushes it forward, driving before it a cartridge from the carrier into its particular barrel. The breech is thus closed, and as the butt comes opposite the steel plate in cam, the cocking-ring releases the spring, and the needle fires the cartridge. The system continues to revolve, and the lock now being drawn back within the chamber, extracts the empty cartridge-case while retreating, and the latter falls to the ground. (*Vide* also detailed description in the Appendix).

The 0·45-in. gun is sighted with a tangent and fore-sight up to 2400 yds. (8° 23′ elevation).

	cwt.	qrs.	lbs.
Weight of gun	3	3	24
" carriage and limber (empty)	12	2	13

Ammunition in axletree and limber-boxes, 2400 rounds per gun. Weight, about 2 cwt.

Also to be carried in two ammunition carts for six guns, 21,760 rounds, or about 3600 rounds per gun.

The ammunition used is not the Martini-Henry; for though it would be advisable to employ it, the difficulties in the way have not yet been overcome.

The bullet of lead and tin weighs 480 grs., and the powder charge is 85 grs. The cartridge-case is of brass, drawn solid.

THE MITRAILLEUSE OF NOBEL.

This mitrailleuse is identical, in all its principal parts, with the Gatling gun.* It seems to have rather lost than gained in efficiency by the greater number of the so-called improvements, according to the Swedo-Norwegian report.†

These specially aimed at a reduction of weight, and an increased rapidity of fire.

The reduction of weight was obtained by the construction of a lighter carriage, detrimental to the accuracy of fire, and by a diminution in height of the breast of the piece; also by reducing the number of barrels to six, and decreasing their length.

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* It has a gun-metal cylinder, corresponding to frame and outside of the Gatling. The main shaft is hollow, and of steel, and is turned by an organ handle at rear end. It has two bearings—viz., the cascable plate in rear, and the front part of external tube.

† The Russian authorities, however, seem satisfied with their weapon; and we find that when the new organisation is complete (as it probably will be this year), they will have mitrailleur batteries of eight guns each—*i.e.*, one battery to each brigade of field artillery.

Increased rapidity of fire seems to have been aimed at by the fixing of the crank or handle upon the axis of motion of the system, so as to act directly. This rendered the rotation more rapid; but the drums had to be replaced by small magazines, containing 25 cartridges each, the result of which is that continual changes of magazine have actually reduced the rapidity of fire which it was sought to increase.

This mitrailleuse has also undergone several alterations tending to the better insertion of the cartridges, and the better extraction of the empty cases.*

THE FRENCH MITRAILLEUSE.

The French mitrailleuse is composed of 25 barrels, fixed in five layers, one above the other; the whole surrounded with a bronze casing, so as to give it the appearance of a field gun.

This casing is prolonged to the rear, when it forms a box open at the top, in which the loading apparatus is moved backwards and forwards by means of a screw placed in prolongation of the medial line.

The loading apparatus is composed of two parts—viz., 1st, a cartridge-plate, with 25 holes corresponding to the barrels, and in which the cartridges are placed; and 2nd, a firing arrangement which contains 25 locks, each composed of a piston and a spiral spring.

In loading, the cartridge-plate and the firing arrangement are carried forward by the screw, during which operation the cartridges are partly pushed into the barrels; the pistons being brought up by a closing disc, which also produces the cocking of the piece.

This closing disc has 25 holes, and can, by means of a lever-handle fixed to the right side of the piece, be drawn sufficiently to the side to allow the pistons to pass through the corresponding holes, and so to ignite the cartridges. The number of rounds which can be habitually fired with this mitrailleuse is only 100 to 150 per minute.

Its service is laborious, and it easily gets out of order. It is also possible for the cartridges to be fired before the breech arrangement is properly closed—a very serious defect.

THE MITRAILLEUSE OF MONTIGNY AND CHRISTOPHE.

This mitrailleuse resembles the French in general principles, but differs from it in the following details:—

It is furnished with 37 barrels instead of 25, and the screw by means of which the loading apparatus is brought into play is replaced by a lever moving in the same vertical plane as the medial line.

The handle which gives rotation to the closing disc of the "pistons and strikers" is also replaced by a long lever, which moves on the right side of the piece, parallel to the preceding one.

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* This description is taken principally from the Swedish report, but it is believed that a drum similar to that used with our Gatling is now employed with the Nobel gun, as mentioned already.

This mitrailleuse has fired as many as 350 to 400 rounds per minute. Under ordinary circumstances, however, this rate cannot be expected. We may take its normal rate of fire as about 200 rounds per minute.*

The construction appears simple, but it is really somewhat complicated, the mechanism being composed of a number of parts. Notwithstanding these defects, it is solid, and not easily liable to get out of order.†

THE MITRAILLEUSES OF WINBORG AND PALMCRANTZ.

(As described by the Swedo-Norwegian Committee's Report).

The inventors above named submitted for trial two mitrailleuses, on the construction of which the Committee do not give a detailed report, as the inventions have not yet been patented.

The earlier in date of these pieces—called No. 1—has ten working barrels, successively charged from a magazine containing 100 cartridges.

The construction is very simple and solid, comparing well in these two particulars with the Gatling gun.

In the experiments carried out by the Committee, the mitrailleuse No. 1 proved itself to be perfectly accurate, but the rapidity of fire rarely exceeded 300 rounds per minute. If this limit was passed, the sticking of a cartridge was apt to lead to delay in the fire.

This mitrailleuse is not liable to damage from rust; its mechanism being entirely protected, and almost altogether of bronze.

It only weighs about 200 lbs., and its magazines would not much increase the weight of the ammunition. It has a lateral pointing apparatus, and a scattering arrangement. The former is of the usual construction; the latter is simpler than other similar known arrangements, and also easily fixed and worked.

Under no circumstances are more than two men required for the service of this arm; and should "scattering" not be deemed requisite, one man will suffice.

Mitrailleuse No. 2 consists of ten barrels, placed in the same horizontal plane. They are charged simultaneously, and one magazine is capable of containing 250 rounds.

The discharge may take place as a salvo, or round after round.

The whole of the mechanism is put in motion by a lever, working horizontally on the right side of the piece.

The construction of this mitrailleuse is far simpler and stronger than that of all others known,‡ and of a nature little liable to derangement by rust or fouling.

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* While changing the discs, one is more than usually liable to accidents, which would considerably reduce the rate of firing.

† A full description of this mitrailleur, with plate, is given in a paper of Major Fosbery's, in "Journal, U.S.I.," No. LVI. pp. 546-7. Mr. Goddard's invention of 1853 (p. 3) somewhat resembles this arm.

‡ As will be seen further on, the simplicity claimed is rather doubtful.

During the experiments carried out by the Committee, which occupied about eight days, this mitrailleuse was stored in a damp cellar, and not cleaned between the firings. The rust appeared in no way to interfere with the working of the mechanism. 450 rounds per minute were fired from it—a magazine being emptied with a rapidity amounting to a discharge of 600 rounds per minute. This rapidity did not interfere with the regular working of the mechanism.

The inventors contemplate shortening slightly the motion of the lever, in which case the Committee believed that a rate of fire of from 400 to 500 rounds per minute could be attained with certainty.

It can be served in all cases by one man.

No. 2. (*According to Report of French Committee*). *Vide Plate II.*

The report of the Swedo-Norwegian Committee of 1872 gave only a general description of this mitrailleuse, but no account of its mechanism. Since the date of that report, a French Committee has experimented with this weapon at Bourges, and in the "Revue de l'Artillerie" of February, 1874, we find a full description, illustrated by plates. From this account, the following details have been taken.

Before entering into them, it may be well to mention the results of the French experiments, and the conclusion their Committee arrived at, which differ somewhat from those of the Swedo-Norwegian officers.

2850 rounds were fired with effect, as shown by table below. Two rows of targets (44 yds. apart) were used, each row being about 8 ft. high and 86 ft. in length.

Distances. (about).	Number of bullets fired.	Percentage of bullets striking.	
		1st row.	2nd row.
yds. 440	500	33·6	38·5
880	500	52·3	42·7
1100	1350	37·2	31·8
1320	500	19·8	25·8
Total	2850		

Some of the firing was slow, and at other times it was carried out as quickly as possible, at the rate of 500 rounds a minute.

Several accidents happened during this rapid firing, which interrupted it for a certain time. They were principally owing to the cartridges not acting sufficiently as a gas check.

In the most serious, which occurred twice, the striker was driven violently back out of its groove, (by the gas), pushing the cock back with it.

The cock became fixed in the longitudinal slit which guided it, and the motion of the lever was stopped until the striker and cock had been put back in their places.

Other stoppages were caused by difficulty of extraction when the rapidity of fire was great; the empty cartridges not being withdrawn quickly enough.

The Committee concluded—

1. That the closing of the breech was faulty (not sufficiently close); and that, unless a stronger cartridge affording a sufficient gas check was used,* some change in the mechanism was necessary on that account.

2. That the striker should be furnished with a stop, to prevent its being driven backwards out of the piston or plunger; and an arrangement made for the continual supply of the magazine.

Though its advantages as to rapidity of fire are great, the Committee consider the mechanism of this mitrailleuse to be complicated, and its "assemblage" long and difficult.

On the whole, they had doubts as to its efficiency for field service, which careful experiments alone could determine.

Details.

The system consists of a rectangular frame of cast-iron (*A'A'*, Figs. 1, 2, and 3), the sides of which are connected by three plates or transoms (*aa*, Figs. 2 and 3). The frame is furnished with trunnions, and is capable also of lateral movement on a pivot.

The ten barrels are placed side by side in the frame, their muzzle ends passing through the front transom, while the breech ends are screwed into the middle transom.

Between this middle transom and the rear one there is a parallelopiped box, containing the mechanism (Figs. 1 and 2), which is capable of movement backwards or forwards.†

In it are ten pistons or plungers,‡ corresponding to the barrels. These are of steel, pierced with a channel in which a needle or striker moves freely, and are furnished with an extractor on the right side.

Behind each plunger is a cylindrical cock of steel, with a projecting tenon underneath; and behind the cock, again, a strong spiral spring.

The under surface of the box, or "lock," carries—

1. A "closing cam" (*e*, Figs. 3 and 4), which pivots on an axis, and by means of two curved slits gives reciprocating motion to a couple of bolts (*ff*, Figs. 3 and 4).

When the lock is moved up so that the breech ends of the barrels are closed, these bolts are pushed into corresponding holes in the sides of the frame, and so secure the lock in that position for firing.

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* It should be mentioned that in the experiments at Christiana, barrels rifled on the Remington system were used; while at Bourges the barrels had the Berdan rifling (used in the Russian service small-arm). This may account, in some measure, for the different results arrived at.

† This box is termed the "lock" in description given.

‡ The "plungers" resemble very nearly the locks of a Gatling gun.

2. A "director" (*g*, Figs. 3 and 4); which is a plate, or cam, secured to the lock.

Motion is given to the latter by means of a curved slit in this plate, into which fits a pin on the "directing lever" (*l*, Fig. 3). A portion of this slit is the arc of a circle, concentric with that described by the arm; the remainder is curved, so that as the arm moves from right to left the lock advances, and *vice versâ.*

Upon the brackets, secured to the rear transom, is a "detent" (*h*, Figs. 3 and 4). This is a plate, capable of transverse movement, and having ten teeth bevelled on the left side, and increasing in thickness (to the amount of one-tenth) from right to left.

Its use is to compress (by means of the tenons of the cocks) the whole of the spiral striker springs, and then to release them one by one.

A powerful spring (*i*, Fig. 3), fastened to the transom, presses the detent against the left side of the frame.

The detent, however, is moved to the right, as the lock is drawn back, by the bevelled part of the tenons of the cocks (*d*, Figs. 3 and 4) bearing against the bevelled sides of the teeth, until these tenons pass behind the teeth and bite, when the spring before mentioned drives it sharply to the left again with a loud click.

Movement to the right is afterwards caused by the arm (*l*) pushing the detent to the right, and releasing each tenon (and so the cock and striker) in turn.

The movements of the closing cam, director (with the lock), and detent, are governed by a "directing arm," or lever (*l*), which has a tooth (*T*) at one end moving in the curved slit of the closing cam (*e*), and a projection (*P*) on its upper surface fitting into the groove of the director. The other end is fixed to a strong vertical axis (*m*, Figs. 3 and 4) called the "motive axis," which is secured to the rear transom, and plays a prominent part in the mechanism.

The "carrier," or feeder (*yy*, Figs. 1, 3, and 4), is a plate of copper, having ten longitudinal holes for the cartridge-cases to drop through when extracted, and a similar number of strips on which to carry the cartridges when loading. It is capable of a slight lateral motion, which is given by a forked arm (*s*, Fig. 3) pivoting freely on the motive axis (*m*), and moved to the right or left by a projection on the under surface of the lock.

A bent lever or "handle" (*n*) is fixed to the motive axis (*m*). It can move backwards and forwards under the lock in a horizontal plane, and is the immediate means of putting the whole of the mechanism in motion. To its inner end (where fixed to the axis) is secured a curved arm (*o*), having a pin (*p*) at its extremity. The pin works in a curved slit in an eccentric plate (*E*), by which lateral dispersion is given as follows:—

There is in the eccentric another slit, into which fits the tenon of a crank (*r*), capable of being clamped in the slit where required. The outer end of the crank is secured to a horizontal traversing block of brass (*q*). The block (*q*) is fastened to the head of the elevating screw, and has a mortice along its interior face, in which slides a projecting tenon on the back of the rear transom of gun-frame.

When, therefore, the handle (*n*) is moved, together with its arm (*o*), the pin (*p*) acts on the eccentric (*E*), and so upon the crank (*r*), which would cause the block (*q*) to slide along the projecting tenon upon rear transom of gun-frame. The block, however, is immoveable laterally, being secured to the elevating screw; consequently the gun-frame moves instead, and lateral dispersion is effected.

By clamping the tenon of the crank (*r*) at different distances along the groove of eccentric, the angle of dispersion can be regulated as desired.

The carrier is supplied with cartridges by a magazine in the shape of a parallelopiped box having ten vertical divisions, each of which holds 25 cartridges. Grooves are cut in the sides of the divisions at the rear, for the projecting part of the base of the cartridge to slide in. The magazine has a moveable bottom, with ten rectangular holes, through which the cartridges drop on to the carrier ten at a time.

Action.

The action of the mechanism is as follows, supposing the discharge to have been just completed, the lock closing the breech end of the barrels, and being still secured in its place by the two bolts (*ff*) :—

1. The handle (*n*) begins to move to the rear; the projection of arm (*l*) traverses the concentric part of cam (*g*), and the lock remains steady. The pin (*p*) of bent arm (*o*) travels along the curve of eccentric (*E*), and the gun-frame therefore moves from left to right until it gains its normal position (as before firing), when the circular part of eccentric groove is reached by *p*.

The spring (*i*), acting on detent, drives it from right to left.

2. As the movement continues, the arm (*l*), by means of tenon (*T*), acts on the closing cam (*e*) and withdraws the bolts (*ff*), leaving the lock free.

3. At the moment these bolts are withdrawn, the projection (*P*) engages in the eccentric part of director, and the lock begins to move back, drawing with it the plungers which extract the cartridge-cases.

4. When the plungers have quite left the barrels, the projection on lock bears against the forked arm (*s*) and so pushes the carrier to the left. At the same time, the tenons of the locks begin to press against the teeth of the detent, carrying the latter to the right.

The empty cartridge-cases fall to the ground. The tenons of the cocks pass behind and bite in the teeth of detent, which is driven to the left by the spring (*i*).

The handle (*n*) is now as far back as possible, and the lock in its furthest position from the barrels.

The handle next moves forwards with the following effects:—

1. The projection on directing arm acts on director, and moves the lock to the front. The lock, pressing against fork (*s*), drives the carrier to the right, and the cartridges fall on the grooves of the latter.

2. The lock advances to the front, and the spiral springs are compressed by the cocks, which are kept back by the detent. The plungers push the cartridges into the barrels.

3. When the cartridges are quite home, the lock stops, and the pin on directing arm causes the closing cam to drive the bolts (*ff*) into the holes in the gun-frame, so that the breech-closing is complete.

4. The directing arm now begins to act on the detent, carrying it to the right.

Each cock is released in turn from the tooth which retains it, and the striker pertaining to it is driven forward in consequence. As the first one is released, the curved arm (*o*) begins to act on the eccentric (*E*), causing the gun-frame to move in the horizontal plane.

This movement continues while the ten barrels are being fired; its amplitude (as already explained, p. 30) being regulated by the clamping of the tenon of crank (*r*).

The carriage is of iron, consisting of two brackets, on the upper part of which is secured a horizontal plate of iron in which the pivot of the gun-frame works.

The cartridge is of brass, containing a charge of 70 grains of powder, and a cylindro-ogival leaden bullet with hollow base, which weighs 355 grains. With cap, &c., the cartridge weighs 463 grains.

Weight.

	cwt.	qrs.	lbs.
The frame, barrels, &c., with pivot	2	2	6
Carriage, with elevating screw	1	1	8
Two wheels	1	0	20
A full magazine, containing 250 cartridges	0	0	24
Total	5	1	2

THE FELDL REVOLVER CANNON.

(*Used by the Bavarians in* 1870).

This consisted of four parallel barrels, rifled on the Werder system. Its practical rate of fire was about 300 rounds per minute, and a lateral spread of 28° could be given to it.

	lbs.
The weight of gun was	963
" limber, with 6864 rounds	1451

This gun was drawn by four horses.

The Hotchkiss Revolver Cannon.*

This is a species of mitrailleur meant to fire small percussion shells, weighing (when filled) 570 grammes—about 1¼ lbs.

In external appearance it much resembles a Gatling gun, but its mechanism is quite different.

Six barrels of steel pass through two discs, secured to a shaft or axis which is capable of revolution in a rigid frame of wrought-iron. Underneath the system there is, as in the Gatling, an arrangement to allow of the gun pivoting for lateral spread, and also trunnions to allow of movement in a vertical plane.

A spindle, with a worm at the interior end, and at right angles to the main shaft, gears with a pinion at breech end of the latter, so that by turning a handle on the other end of spindle, at the right side of the piece, the axis and barrels are made to rotate.

The thread of the worm is an interrupted one, about one-half of each turn being at right angles to axis of spindle. The system does not therefore rotate during half of each turn, and in this half discharge takes place.

There is only one lock, opposite to which each barrel is brought in turn. This lock consists merely of a striker and a strong spiral spring.

The spring is compressed by a cam, as rotation proceeds; and when a barrel comes round so that its breech end fits against a piece of steel let into breech part of mechanism, the spring is released and the charge exploded.

The full cartridges are pushed into, and the empty ones extracted from, the barrels by a plunger and extractor, secured respectively to the ends of two ratchet bars, which are caused to advance and retire by means of an arm with projecting pin secured to the end of the spindle which rotates the main shaft.

This pin works in a slit-bar, fastened at its centre to the lower ratchet; and so, with the assistance of a loose pinion gearing into both the ratchets, they are made to advance and retreat alternately as the handle goes round.

When the ratchets are in their extreme positions, the slit-bar remains for an instant motionless. The pin does not act for that time, one side of the slit being cut out in a curve. The barrels are not rotating just at that moment, so the cartridge is in one case pushed in, and in the other withdrawn, as one ratchet or the other acts.

---

* For the reasons given (pp. 8–9), it does not seem probable that a weapon of this description will be found to answer. Though firing shells, the latter would be too small to penetrate cover at any distance. Still, the idea is somewhat novel, as well as the mechanism, in which ratchet bars play a prominent part.

APPENDIX.

Action of the Service Gatling Gun.

Since completing the foregoing, I have been enabled, by the kindness of Captain Andrew Noble (late Royal Artillery), of the Elswick Ordnance Company,[*] to give the attached Plate III., showing the development of the cam which causes the reciprocal action of the locks in our service Gatling. The plate also allows one to see at a glance the ten locks, each in a different part of its cycle of action, and shows how the cocking-ring or cam draws back and then releases the hammer and firing pin.

Locks V. and VI. are in section, the remainder in plan. The line *ab* across the sections of the ten barrels denotes the commencement of their rifling.

The curved gun-metal cam *AA*, as well as the spiral steel cam or cocking-ring *R*, is stationary; and as the spindle carrying lock-chamber with locks and cartridge-carrier revolves, the following action occurs:—

At I. a cartridge has just dropped on cartridge-carrier in front of lock.

At II. it has been a little pushed forward, as the base of the lock advances up the curve of *AA*.

At III. and IV. we see the cartridge pushed into the barrel.

At IV. the projecting stud of the hammer (shown in each lock by a dotted curve) also comes in contact with the cocking-cam *R*.

At V. the base of the lock has reached the flat part of the cam, the spring has been fully compressed, and the cartridge pushed right home.

At VI., the stud of the hammer being released from cocking-ring, the needle flies forward and explodes the cartridge. The base of the lock at that time rests against a plate of steel let into gun-metal cam at *SS*.

At VII. the lock begins to retreat, its base being forced down the opposite curve of cam. The extractor commences to extract empty case.

At VIII. and IX. the empty cartridge-case is still further withdrawn; while at X. the case has been extracted, and the lock itself, having been drawn clear of the barrel, is ready to pass again to position I.

Thus it will be seen that, during each complete revolution of the barrels and lock chamber, every lock in succession loads, fires, and extracts a cartridge-case; so that ten shots are fired in each revolution.

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[*] Captain Noble very kindly had the drawing made, from which the plate was reduced and lithographed.

Comparative Equipment of a 9-pr. Field Gun and Gatling Batteries.

9-PR. FIELD BATTERY, 6 GUNS.		GATLING BATTERY, 12 GUNS, ·45-IN. CAL.*	
Captain (Major)	1	Captain (Major)	1
Second Captain (Captain)	1	Second Captain (Captain)	1
Lieutenants	3	Lieutenants	3
Assistant-Surgeon	1	Assistant-Surgeon	1
Total	6	Total	6

Serjeant-Major	1	Serjeant-Major	1
Quarter-Master-Serjeant	1	Quarter-Master-Serjeant	1
Serjeants	3	Serjeants	6
Corporals	6	Corporals	6
Bombardiers	6		
Gunners	85	Gunners	60
Drivers	81	Drivers	20
Trumpeters	2	Trumpeters	2
Farrier	1	Farrier	1
Shoeing-Smiths	4	Shoeing-Smiths	2
Collar-Makers	2	Collar-Maker	1
Wheelers	2	Wheeler	1
Total	197	Total	101

Guns	6	Gatling guns	12
Wagons	12	Small-arm ammunition carts	6
Store wagon	1	Store wagon	1
Forge wagon	1	Forge and general service wagon combined	1
General service wagon	1		
Store cart	1		
Rounds per gun	214	2208 cartridges carried with each gun	26,496
		9000 cartridges in each S. A. A. cart	54,000
			12)80,496
		Cartridges per gun	6,708

Riding Horses.		*Riding Horses.*	
Officers'	12	Officers'	12
Staff-Serjeants'	2	Staff-Serjeants'	2
N.C. officers'	12	N.C. officers'	12
Trumpeters'	2	Trumpeters'	2
Farrier's	1	Farrier's	1
Shoeing-Smith's	1	Shoeing-Smith's	1
Spare	4	Spare	4
Total	34	Total	34

Draught Horses.		*Draught Horses.*	
Guns	48	Guns	24
Ammunition wagons	72	Small-arm ammunition cart	12
Store wagon	6	Store wagon	6
Forge	6	Forge and general service wagon combined	6
General service	4		
Store cart	2		
Spare	12	Spare	8
	150		56
Total horses	184	Total horses	90

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* As recommended by Colonel Wray's Committee.

The total weight of draught of the Gatling is as follows:—

	cwt.	qrs.	lbs.
Gun carriage, when complete	7	0	7½
Limber, „	5	0	25
Six drums, filled	3	2	0
Total	15	3	4½

Space occupied by a Battery of six 9-pr. Field Guns, as compared with that occupied by a Battery of twelve Gatlings.

9-pr. Battery.

	Length in yds.	Total.
6 guns, 8 horses	19	114
12 wagons, 6 horses	15	180
1 store wagon, 6 horses ...	15	15
1 forge, 6 horses	15	15
1 general service wagon, 4 horses	11	11
1 store cart, 2 horses	8	8
Total, in yds.		353

Battery of 12 Gatlings.

	Length in yds.	Total.
12 guns, 2 horses	7	84
6 carts, 2 horses	7	42
1 store wagon, 6 horses	15	15
1 general service wagon and forge combined, 6 horses	15	15
Total, in yds.		156

The following tables give a summary of the results obtained from firing, in competition, the pieces mentioned. The practice was carried on by Colonel Wray's Committee in August and September, 1870:—

1st Experiment.—At a line of targets 9 ins. by 9 ins., representing 90 cavalry or 100 infantry. Shrapnel shell only used with the field guns. Firing against time, 2 minutes.

Range, 300 yds.	Weight of ammunition.	No. of hits.	Range, 400 yds.	Weight of ammunition.	No. of hits.	Range, 600 yds.	Weight of ammunition.	No. of hits.	Range, 800 yds.	Weight of ammunition.	No. of hits.	Range, 1000 yds.	Weight of ammunition.	No. of hits.
	lbs.			lbs.			lbs.			lbs.			lbs.	
Small Gatling	53	369	Small Gatling	39	310	Small Gatling	56	522	Small Gatling	30·5	229	9-pr. M.L.	86	294
12-pr. B.L.	121·5	268	9-pr. M.L.	118	236	9-pr. M.L.	75	263	Mitrailleur	25	154	12-pr. B.L.	94·5	218
9-pr. M.L.	107	208	Mitrailleur	30	178	12-pr. B.L.	94·5	142	12-pr. B.L.	82	152	Small Gatling	41·5	62
Mitrailleur	25	171	12-pr. B.L.	121·5	166	Mitrailleur	30	127	9-pr. M.L.	53	118	Martini-Henry	9	47
Martini-Henry	15	74	Snider	9	77	Snider	9	63	Martini-Henry	10	66	Mitrailleur	30	33
Snider	8	63	Martini-Henry	17	68	Martini-Henry	11	52	Snider	10	48			

mparative Effect of Field Guns (12 *and* 9-*pr.*) *and small Mitrailleuses, at different ranges, summed up, and weight of Ammunition expended shown.*

1st Experiment.								2nd Experiment.							
Small Gatling.		Mitrailleur.		12-pr. B.L.		9-pr. M.L.		Small Gatling.		Mitrailleur.		12-pr. B.L.		9-pr. M.L.	
lbs.	hits.	lbs.	hits.	lbs.	hits.	lbs.	hits.	lbs.	hits.	lbs.	hits.	lbs.	hits.	lbs.	hits.
53	369	25	171	121·5	268	107	208	—	—	25	172	60	138	45	162
39	310	30	178	121·5	166	118	236	16	169	25	177	60	118	45	110
56	522	30	127	94·5	142	75	283	—	—	25	107	60	164	45	78
30·5	229	25	154	82·0	152	53	118	16	183	25	106	60	203	45	124
41·5	62	30	83	94·5	218	86	294	—	—	—	—	—	—	—	—
220	1492	140	663	514	946	439	1139	32	352	100	562	240	623	180	474

3rd Experiment.								4th Experiment.							
Small Gatling.		Mitrailleur.		12-pr. B.L.		9-pr. M.L.		Small Gatling.		Mitrailleur.		12-pr. B.L.		9-pr. M.L.	
lbs.	hits.	lbs.	hits.	lbs.	hits.	lbs.	hits.	lbs.	hits.	lbs.	hits.	lbs.	hits.	lbs.	hits.
26	204	50	201	132	251	108	191	39	312	45	122	67·5	29	53	74
47	104	37	68	144	326	117	248	63	162	55	83	67·5	82	53	34
—	—	—	—	—	—	—	—	63	177	55	9	67·5	39	53	47
75	308	87	269	276	577	225	439	165	651	145	214	202·5	140	159	155

Comparison of Total Effects v. *Weight of Ammunition expended, at ranges under* 1400 *yds.* (*Vide* No. 1 and 2 Experiments).

The small Gatling gun, weighing 3 cwt., expended 492 lbs. of ammn. and scored 2803 hits.
„ Montigny mitrailleur „ 3 „ 472 „ „ 1708 „
„ 12-pr. B.L. „ 8 „ 1232·5 „ „ 2286 „
„ 9-pr. M.L. „ 8 „ 1013 „ „ 2207 „

Comparison of Field Guns (12-*pr. and* 9-*pr.*) *with the large and medium Gatling Guns, at ranges exceeding* 1400 *yds.; showing the weight of Ammunition expended.* (See No. 3 Experiment).

The large Gatling gun, weighing 6 cwt., expended 298 lbs. of ammn. and scored 111 hits.
„ medium „ „ 5 „ 241 „ „ 209 „
„ 12-pr. B.L. gun „ 8 „ 312 „ „ 258 „
„ 9-pr. M.L. „ „ 8 „ 225 „ „ 219 „

Note.—The practice of the guns on this occasion was unusually bad, and the experimental segment shell of the 9-pr. M.L. most imperfect.

Results of Experimental Firing carried on in October 1873, *at Fort Monroe, Virginia, by a Board of U.S. Officers, General Gillmore President, the pieces tried being* 0·42-*in. calibre Gatling Gun,* 4·62-*in. calibre Bronze Gun* (12-*pr. Napoleon*), *and* 8-*in. Siege Howitzer.*

Canvass target, 9 ft. high by 45 ft. wide. At 500 yds.

Pieces and ammunition employed.	No. of shots fired.	No. of hits.
0·42-in. calibre Gatling gun, firing solid shot;* time, 1 min. 30 secs. ...	600	557
12-pr. Napoleon, with time fuze, firing spherical case containing 82 lead balls 0·69 in. diameter; 7 rounds fired; time, 1 min. 30 secs.	574 lead balls	55
12-pr. Napoleon, 6 rounds fired; time, 1 min. 30 secs.	492 lead balls	184
8-in. siege howitzer, with time fuze, firing spherical case containing 486 lead balls 0·69 in. diameter; 4 rounds fired; time, 1 min. 30 secs.	1944 lead balls	112
At 800 yds.		
0·42-in. calibre Gatling gun, firing solid shot, deliberately (aim unknowingly too high)	600	106
0·42-in. Gatling gun, firing solid shot, deliberately	600	534
12-pr. Napoleon gun, with time fuze and spherical case, as above; 7 rounds fired deliberately	574 lead balls	3
12-pr. Napoleon gun, with time fuze and spherical case as above; 7 rounds fired deliberately	574 lead balls	35
8-in. siege howitzer, with time fuze and spherical case, as at 500 yds.; 4 rounds fired deliberately	1944 lead balls	0

* The ammunition used with this Gatling was "Berdan's centre-fire metallic case cartridge."

Weight.

	grs.
0·42-in. calibre projectile	370
Metallic case and lubricant	163
Powder (Hazard's Gatling powder, No. 1)	77
	610

557

65

94

2